California Energy Commission

Energy Storage
Safety Workshop

August 19, 2015

Energy Storage Safety

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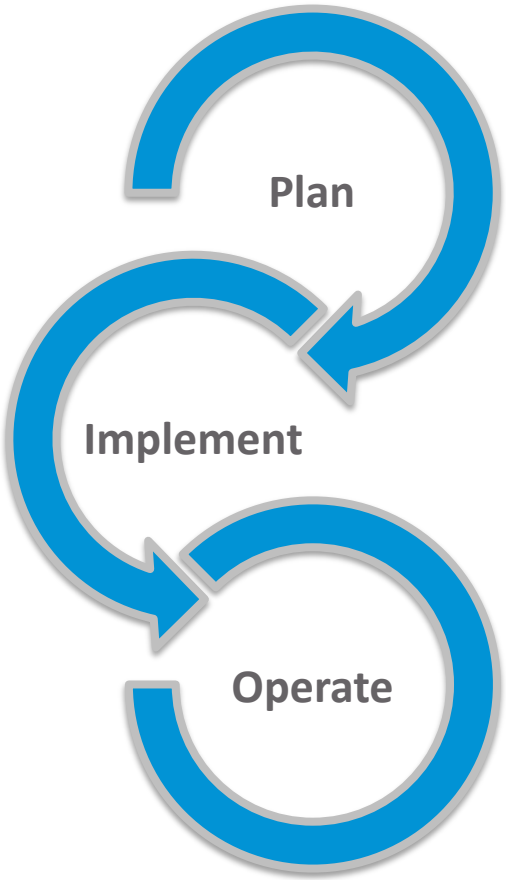
Distributed Energy Resources

SDGE connected

A Sempra Energy utility℠

Energy Storage Integration – Learnings from the Field

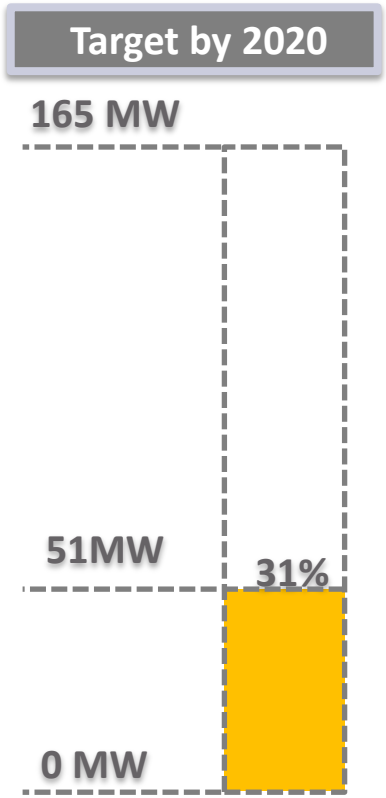


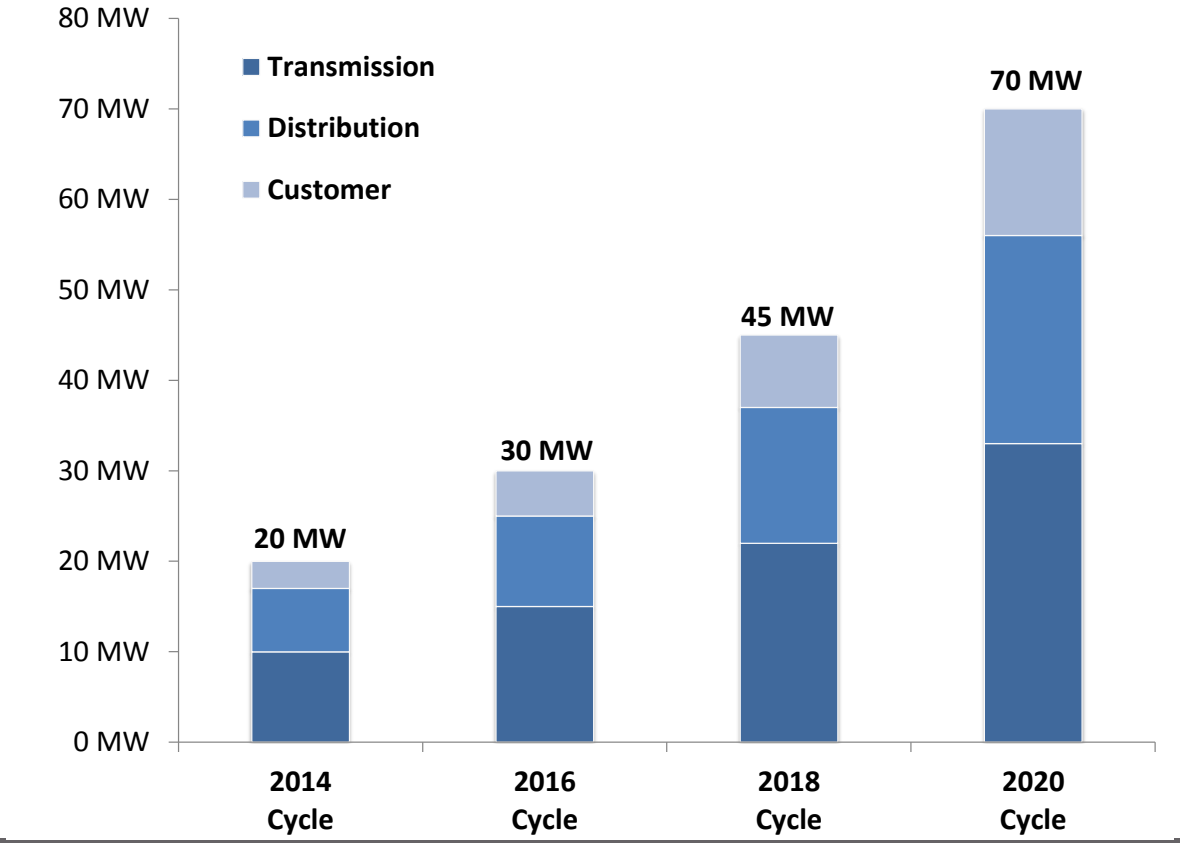
Safety of Energy Storage

- Safety Standards for Grid-Scale ESS are not widely available today
- Robust system specifications critical
- Functional and effective:
  - remote monitoring & notification
  - inspection & maintenance protocols
  - protection/suppression systems
- Internal and external training
  - field personnel
  - first responders

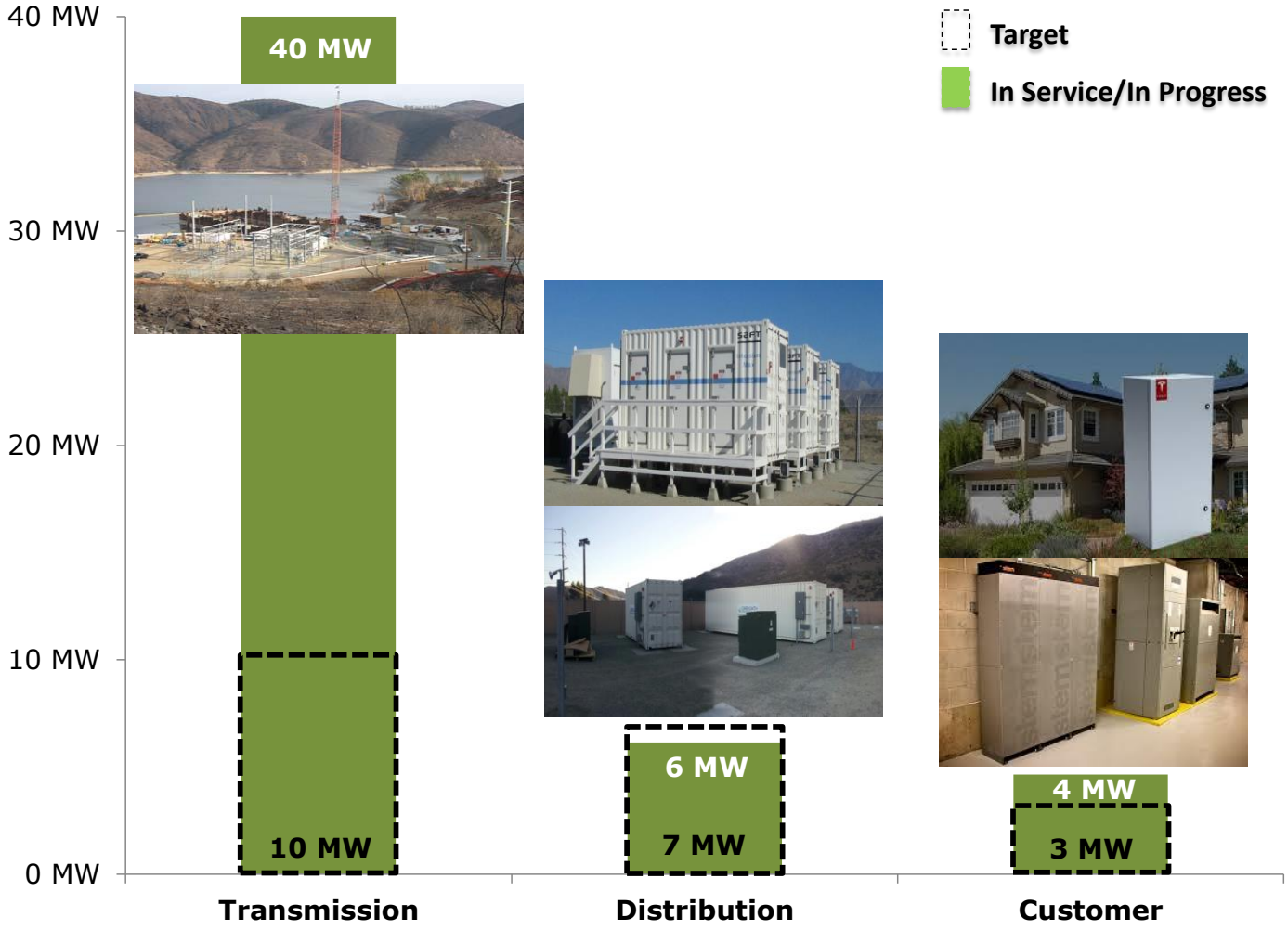
Energy Storage Procurement Target

SDG&E has an energy storage procurement target of **165 MW.** SDG&E has achieved **31%** based on existing/in-progress projects **(51MW).** Projects procured pursuant to the 2014 All Source RFO and 2014 Distribution RFP are expected to significantly increase progress towards the targets.





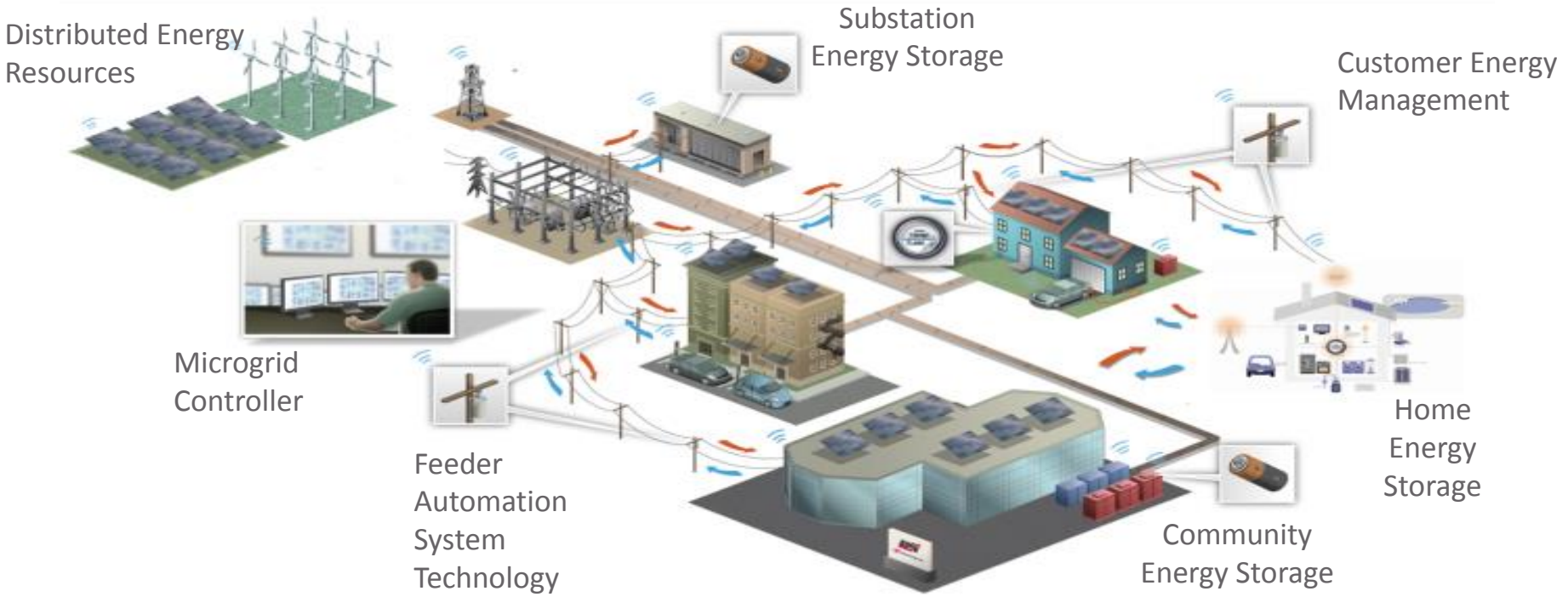
Energy Storage Systems – By Domain



Borrego Springs Demonstration Project

Utilize advanced technologies to integrate and manage distributed resources within the Smart Grid

Budget:	$8.0M DOE and $2.8M CEC plus matching funds from SDG&E and partners
Benefits:	▪ Integrate and leverage various generation and storage configurations ▪ Reduce the peak load of feeders and enhance system reliability ▪ Enable customers to become more active participants in managing their energy use



Borrego Springs Demonstration Project

Substation Energy Storage

- Borrego Springs
  - Gen 1: 500 kW/1.5 MWh ESS
  - Gen 2: 1 MW/3 MWh ESS added
- Modes of Operation
  - Peak Shaving/Load Following
  - Renewable Smoothing
  - Support Islanding Operation
  - Blackstart Synchronization

Borrego Springs Demonstration Project

Community Energy Storage

- Borrego Springs
  - (3) 25 kW/50 kWh ESS
- Modes of Operation
  - Operated independently or as a fleet
  - Peak Shaving/Load Following
  - Renewable Smoothing

Safety is SDG&E's Core Focus

Regardless of the Utility function, SDG&E's Overriding Concern is

Safety

- Assurance
  - Maintain highest degree of public safety possible at all times
- Prevention
  - Adhere to methods which avoid unsafe events from occurring
- Minimization of impact
  - Systems designed eliminate or reduce the extent to which an event has impact on perimeter and the immediate systems
- Limits
  - Architecting the system to isolate the consequences of an event

Utility Operations Safety and the Role of Standards

- Specific safety standards for grid-scale ESS are largely under-defined
  - DOE is working to raise ESS safety awareness and, with Sandia National Lab, has produced the Energy Storage Safety Strategic Plan
- SDG&E legacy methods for equipment and processes are a starting point
- Existing Standards Development Organization (SDO) protocols will need to provide increased specificity to the technologies
- Applicable standards today include:
  - Site safety: All applicable OSHA, NEC and NFPA requirements
  - Fire: NFPA 704
  - Operation: IEEE 1547/UL1741/UL1741/UL1642
  - Enclosure: NEMA 3R
  - Signage: ANSI Z535
  - Cybersecurity: NISTIR 7628

Safety From the Start – Procurement

- Bid Package includes
  - Well defined objectives, applications and use cases
  - Clearly stated performance expectations
  - System specification including designation of:
    - Applicable safety standards
    - Methods and systems required to assure safety
    - Explicitly defined protocols for remote communications
      - Details of SCADA integrated interconnection and relay protocols
- Requirements for Factory Acceptance Testing & Site Acceptance Testing
- Detailed grid isolation functions and methods are specified
- Vendors generally receptive of the specification
  - No objections to date
  - SDG&E works proactively with bidders/vendors early in the process to address/resolve any ambiguity in our specification.

Safety By Design – Integration Requirements

SDG&E requires all substation ESS interconnection via SCADA switch and prescribed relay settings

- Without permissives from Dist Ops via DMS, these ESS are not enabled to operate
  - Permits the system to operate only under specific conditions
- Host site SCADA switch provides instantaneous remote disconnection, as needed.
- Systems required to meet all IEEE 1547 interconnection requirements
- Systems occupy a dedicated fenced yard with limited access privileges
- Inspection & maintenance processes configured in agreement with vendor recommendations
- Smaller systems:
  - Community-scale ESS siting process similar to conventional pad-mounted equipment and are configured with by-pass switches to enable customers to remain energized during inspection & maintenance
  - Behind-the-meter systems (currently Rule 21) to align with forthcoming UL9540

Safety By R&D Activity – Vendor Partner Engagement

Advanced Inverter Functions being Explored
for Back-up to Critical Loads

- Islanding
  - Dist Ops observation of system operation continuous, but operation independent and automated
  - From the perspective of the circuit, the system is off
- Blackstart
  - Isolation from the grid
  - System start-up supporting critical load occurs only after SCADA switch open
- Resynchronization occurs when the grid function is restored via reference signal from SCADA switch

Safety in the Long Run – Operations

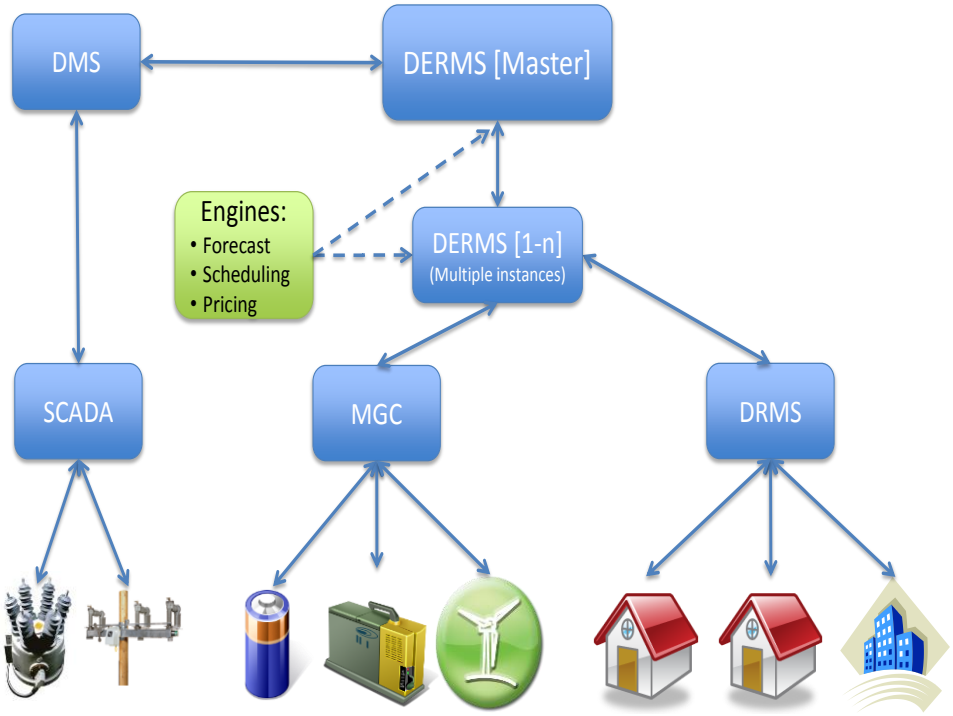
SDG&E maintains a Hierarchical Notification System for Operators to monitor all substation ESS systems

- Continuous in-house remote monitoring of notifications/alerts/alarms
- One-second updates via fiber backhaul
- Event process defined by specific system instrumentation thresholds
  - Warning
  - Shutdown
  - Event (fire or other resulting in key alarm)
- Key Alarm process
  - Operators instantly receive notification of FSS activation
  - Immediate camera check and truck roll to inspect & assure site perimeter safety
  - Open contact with the vendor and local authorities for response orchestration
  - Engage Fire Coordination as necessary

Safety in the Long Run – Networked Operations

SDG&E is Implementing
Distributed Energy Resources Management System (DERMS)

- DERMS continuously monitors and manages any number of DER nodes on the greater grid
  - DERMS has the ability to dispatch each node independently according to optimized functional algorithms
  - Regional conditions determine modes of operation and set points for the systems to respond appropriately in automated fashion
- Dist Ops can override automated modes during episodes when manual operation is required
- Safe operation of DERMS is assured by functional rulesets through advanced integration with DMS



Safety Processes – Response & Protection

- SDG&E Fire Coordinator maintains on-going dialogue with regional authorities
- Internal training modules (2 hour) and safety handbook chapter developed for field personnel and first responders. Annual compliance updates required.
- All trained and certified technicians to adhere to safety protocols:
  - Non conductive, fire retardant clothing
  - Insulated gloves
  - Anti-flash eye and/or face protection
  - Insulated tools > 1000V
  - Insulating shoes or mat > 1000V
  - Applicably rated AC/DC Voltmeter
  - Approved work processes and perimeter for all maintenance & repair

Effective Energy Storage Integration – Key Take Aways

Learnings

- Plan plan plan test test test
- Factory Acceptance Testing is imperative, but…
- There is no substitute for field demonstration
- Siting equipment & permitting are challenging
- Standards development is not at pace with regulatory requirements – creates challenges in terms of approvals
- Never underestimate the complexities of integration
- Nascent technologies require patient implementation
- “Partnering” vendors are essential for safe, reliable and efficient integration of any new technologies
- Involve & educate of all impacted organizations early
- Cannot operate IT & Engineering silos…need blending of skills & close collaboration for best results
- DER, if done correctly, has a very positive grid impact

Thank you for your time!